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NOTES ON THE POINT HOPE SPIT, ALASKA[1]

E. M. KINDLE

Point Hope is a spit of gravel and shingle which extends out into the Arctic Ocean from the northwestern coast of Alaska, about one hundred and twenty-five miles north of the Arctic Circle. It marks the most westerly point reached by the continental shore line north of Kotzebue Sound. After Cape Prince of Wales it is the westernmost point of the continent. (See Fig. 1.) Point Hope extends seaward from the delta of the Kukpuk River and represents the northwestern extension of the barrier beach which curves southeastward to the cliffs at Cape Thompson, a distance of about thirty-five miles. The spit and the delta deposits behind it together extend out a distance of about fifteen miles beyond the bed-rock area of the original shore line. Lagoons and barrier bars are a common feature of the northwestern coast of Alaska, but spits extending out into the sea are unusual and the Point Hope spit is unique in being the only spit along this coast line which projects any notable distance into the sea at right angles to the coast line. Point Barrow and the long bar forming Point Clarence Harbor are the only spits on the northwestern coast of Alaska which are comparable in size with the Point Hope spit. Neither of these, however, shows the finger-like projection from the coast line of Point Hope, each of them curving toward the eastward. The natives have named this rather striking physiographic feature "Tigara," from its fancied resemblance to the index finger of the hand, which the word signifies.

About one and three-fourths miles from its western extremity the Point Hope spit is joined by a bar which is only about one hundred yards in width at the point of junction with the spit. This bar extends in a northeasterly direction nearly to the mainland and forms with the spit a V-shaped figure inside of which are the shallow waters of Marryat Inlet and the delta of the Kukpuk River.

It will be seen by reference to the map (Fig. 2) that the unconsolidated beds which lie to the west of the area of bed-rock outcrops in the neighborhood of the mouth of Kukpuk River cover a rather extensive area. They represent in large part delta deposits and in part foreland and beach deposits. We are here concerned only with the latter. The delta deposits are easily distinguished as a rule and usually consist of interstratified silts and sands overlaid by fine black sediments which are often interbedded with peat-like accumulations of marsh grass turf.[1]

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[1] Published by permission of the Director of the U. S. Geological Survey.

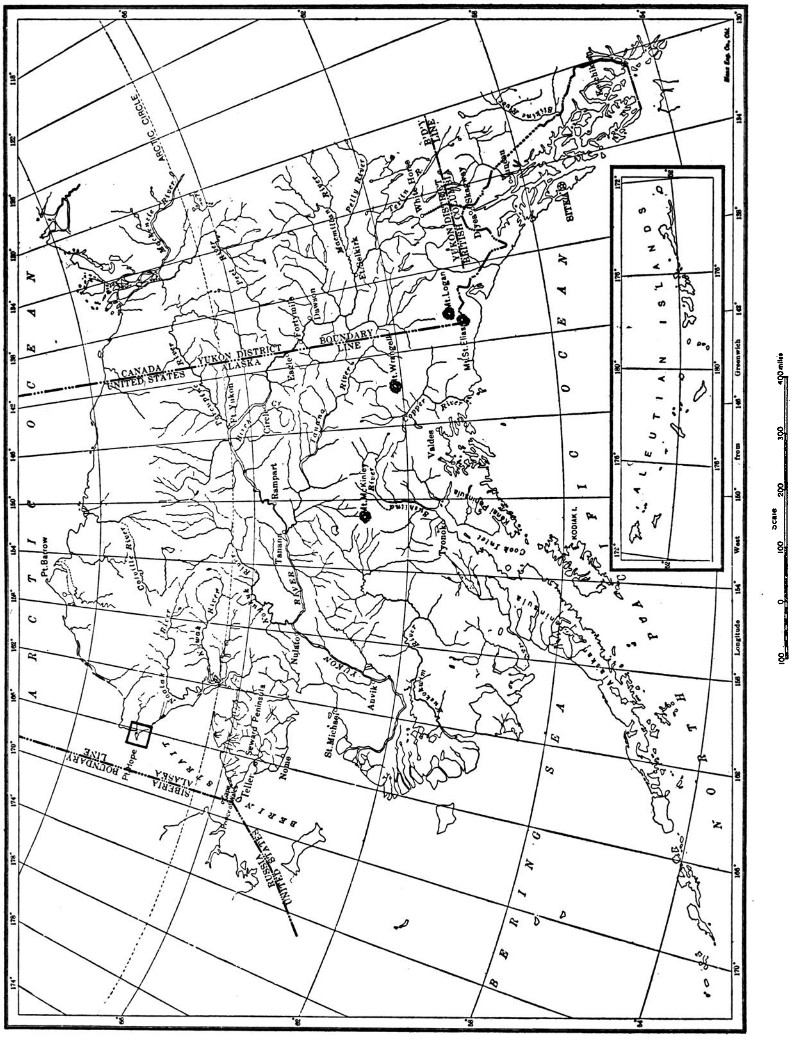

FIG. 1.—Outline map of Alaska, showing by rectangle the area of the Point Hope map.

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[1] Mr. A. J. Collier gives a brief description of the delta deposits in a report on the Cape Lisburne coals, *Bull. U. S. G. S., No. 278*, p. 33, 1906.

A regularly concave shore line connects the base of the spit with the cliffs of Cape Thompson from which most of its materials are derived. A narrow gravel barrier beach, frequently only 100 or 200 feet in width, forms the coast line of this concave beach, a distance of about 25 miles. Behind this beach is a series of lagoonal fresh-water lakes which drain by filtration through the beach. The beach is unbroken by streams entering the sea, except within the first mile to the west of Cape Thompson.

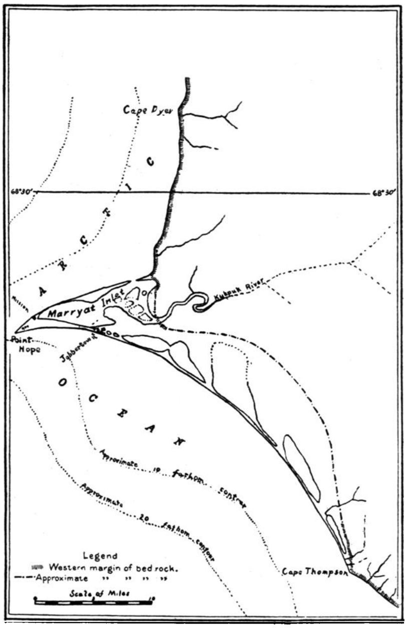

FIG. 2.—Reconnaissance map of Point Hope and adjacent coast line. By E. M. Kindle.

The south shore of the spit is generally steep, while the northwest shore is less abrupt. The point terminates abruptly in rather deep water, 13 fathoms being recorded a few ship's lengths from the tip of the point. Off the south shore the eight-fathom contour runs within a quarter of a mile of the shore toward the western end of the Point. On rounding the Point the soundings decrease rapidly to five fathoms and a shoal with four fathoms at its southern end extends some three miles in a west-northwest directin from the Point.[1]

The materials composing the spit are much coarser than those of many spits. Much of it may be properly called shingle, while coarse gravel and a small proportion of sand comprise the remainder of the material. The coarser materials are composed of limestone and chert. From the point where the spit joins the delta deposits at Jabbertown to its western extremity, its length is about eight miles. The surface of the spit has an elevation ranging from thirteen to seventeen feet above the sea. Its greatest width is near the mission where it is about one mile from the north to the south side.[2] From this point it tapers gradually toward the east. It reaches its minimum width near its base where it is less than a quarter of a mile across.

An interesting feature in the make-up of the spit is a series of regular straight canal-like depressions trending nearly east and west and lying parallel with the south shore. The northwest shore line cuts these channels at an acute angle. The bottoms of the channels are depressed below the general surface of the spit from two to six feet. The shallower ones are entirely dry and would hardly be noticeable were it not for their distinct parallelism with the deeper ones. Water remains throughout the summer in two or three of the deeper ones, and it is from this source that the native village secures its water supply. In width these depressions will range perhaps between forty and one hundred feet, and the intervening spaces will average probably two hundred feet. The sides curve very gently into the surface of the interval separating them, which frequently is slightly convex. These canals all extend to the northwest beach, which cuts them off forming an acute angle with the north border of the depression. To the eastward most if not all of them can be recognized at least two miles from the western extremity of the point. Two of them are considerably deeper at this distance than farther west. Near the base of the spit at Jabbertown most of these depressions have faded out. Observations on the bearing of each of these have shown that the four northernmost of the series differ from the others in direction several degrees and are parallel to the south shore of Marryat Inlet. The south shore of the inlet here bears about S. 73° E. Two of the first four canals south of it have the same bearing, while the other two bear respectively S. 74° and S. 75° E. The other canals to the south of these are nearly parallel with each other and with the south shore. Twelve of the latter have been recognized. The variation in the direction of these is within the limits of S. 83° E. and S. 90° E. Under the name of aggradation lines Dr. F. P. Gulliver describes what appear to be similar features in the Dars foreland in the Baltic Sea, Carraveral foreland, Florida, and other cusps.[1]

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[1] Lieutenant D. H. Jarvis, "Coast Pilot Notes on the Fox Islands Passes, Unalaska Bay, Bering Sea and the Arctic Ocean as far as Pt. Barrow," *Bull. Coast and Geod. Survey, No. 40*, p. 56, 1900.

[2] As a basis for determining the amount of wave-cutting on the northwest shore of the spit by future observers, the distance from the north side of the mission observatory to the water line on the northwest beach was measured on a north and south (true) line and found to be 525 feet.

The writer's observations seem to establish two important facts relative to the present action of destructive and constructive agencies on the spit. The northwest shore is being cut away rather rapidly while the south shore is being built up. The ruins of an ancient Eskimo village, which is being undercut by the waves, afford indisputable proof of the encroachment of the sea on the northwest side. We have also the testimony of a missionary, Dr. John Driggs, who has resided for 18 years near the north shore of the point. He states that 185 feet would be a very conservative estimate of the amount of cutting which has occurred on the north shore during the period of his residence. He informed the writer that the cutting of the shore was accomplished almost entirely during the prevalence of heavy southwesterly or westerly storms. At such times the waves are driven along the beach and carry away its loose materials very rapidly. The writer was shown the door of the old mission chapel standing about sixteen feet above the sea and some two hundred and fifty feet from the beach which was smashed by wave action during a southwest storm of exceptional violence which occurred October 13, 1893. It appears that during this storm the sea was banked up on this coast until one to three feet of water covered nearly all the western portion of the spit.

The evidence that constructional work is in progress on the south side of the spit is based in part on the relative freshness of the gravels

[1] *Proc. Am. Acad. Arts and Sci.*, Vol. XXXIV, p. 180, 1899.

on the north and south sides and the comparative extent to which vegetation has secured a foothold on the two sides. A few varieties of grass, which constitute nearly the sole vegetation, extend everywhere along the north shore up to the limit of wave action. On the south side the gravel is fresh-looking and in many places is entirely barren of vegetation for two or three hundred yards from the shore.

It is interesting to note that the first white men to land on this point were impressed with the recent character of some of the deposits, comprising the spit. Mr. A. Collie, who was a member of the scientific staff of Captain Beechey's expedition to this coast in 1827, made the following observations concerning it:

> To the north of Cape Thompson the coast runs out by means of a low spit to the distance of perhaps 20 miles into the sea. The low point itself seemed to be acquiring almost a daily accession to the basaltic gravel of which the beach was in greater part formed.[1]

The location of the Point Hope spit is undoubtedly due in large measure to the combined influence of the Kukpuk River and a coastwise current which sets northward out of Kotzebue Sound, at from one to three miles an hour. This current appears to be continuous with the current which sets northward through Bering Strait during the summer months. The current through Bering Strait forks a short distance north of the Strait, one branch bearing northwesterly along the Siberian coast, and the other "going north through Kotzebue Sound and thence along the mainland by Cape Seppings, Point Hope, and Icy Cape to Point Barrow at which point it goes off to the unknown northeast."[2]

The drift of the ice-beset "Jeannette" seems to be conclusive evidence of the northwesterly current to the west of the Strait.

The current through Bering Strait may, of course, be greatly accelerated or retarded by the winds, but they do not seem to be ever able to entirely check it. Captain F. W. Beechey recorded that he found a current in Bering Strait running against a heavy gale "at the rate of upward of a mile an hour in a N. 41° W. direction."[3]

The influence of this current is manifested as far south as Teller on Seward Peninsula and it is reported to reach even as far to the eastward as Point Barrow. McClintock found a current setting eastward to the east of Point Barrow with a rate of 18 miles per day.[1] The depth of water affected by this current seems to be but a few feet. The writer observed evidence of this while aboard a schooner anchored off Cape Krusenstern in Kotzebue Sound during a calm. The waters of the sound swarm with various species of medusa and other plankton. From the rail of the anchored schooner these could be seen at and near the surface passing the vessel with a current of one and one-half or two miles an hour. A few feet below the surface, however—perhaps 10 or 12 feet—could be seen the same fauna almost or quite stationary. The shallow character of this northerly current in these waters was noted as early as 1826 by the careful observations of Captain F. W. Beechey who states concerning this current that "at the depth of nine feet its velocity was evidently diminished and at three and five fathoms there was none."[2] Captain Beechey observed also that the water of this current was much fresher than the deeper waters.

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[1] *Zoölogy of Captain Beechey's Voyage,* London, Bohm, 1839, p. 172.

[2] Chas. H. Stockton, *Natl. Geog. Mag.,* Vol. II, 1891, p. 183.

[3] *Narrative of a Voyage to the Pacific and Bering Strait,* Part II, 1831, p. 546.

The writer has had abundant opportunity to note the influence of this current on coast deposits in the course of a 200-mile journey in a small boat along the coast of Seward Peninsula and near Cape Thompson. Almost every stream between the lagoon west of Teller and Cape Prince of Wales is deflected to the right by a bar on entering the sea. The long narrow bar at the mouth of Kanauguk River is a typical example of these bars. In the case of small creeks the bar may be only three or four yards wide, but when present it invariably turns the stream abruptly to the right as it is about to enter the sea. The tendency of the northerly current to deflect streams to the right is illustrated in Kotzebue Sound, by the bar at the mouth of the Inmachuk River. This bar has a length of about a third of a mile and extends nearly across the mouth of the valley occupied by the Inmachuk, forcing the river to enter the sound at the extreme east side of the valley. A small creek at Cape Thompson which is deflected abruptly to the right by a narrow bar is the nearest example to Point Hope of the influence of this current.

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[1] Capt. McClintock, *A Narrative of the Discovery of the Fate of Sir John Franklin and His Company*, p. 72, 1868.

[2] *Op. cit.*, p. 578.

The relative position of shoals and coastal headlands likewise indicates the influence of the northerly current. An extensive shoal extends northward from Cape Prince of Wales for many miles with comparatively deep water south of the cape. At Point Hope a detached shoal with four and one-half feet of water over it lies to the north of the Point with deep water south of the Point. Cape Lisburne likewise has an outlying shoal with five fathoms of water over it, but it lies wholly to the north of the cape. At Point Barrow there is also a shoal lying wholly to the north of the Point.[1]

The bars cited, however, differ from the Point Hope spit in running parallel with the shore. Like them the Point Hope spit appears to have deflected the stream to the north, but unlike them it extends out nearly at right angles to the coast line. The considerable volume of the discharge of the Kukpuk River has no doubt been an important factor in neutralizing the tendency of the coastal current to turn the spit to the north.

In this connection tidal influence may also be considered. The tide, although small in the Arctic Ocean, is not a negligible element in considering the development of shore-line features. The mean range of the tides recorded for the northwest coast of Alaska and the adjacent parts of Siberia ranges from .2 of a foot[2] to $2\frac{1}{4}$ feet.[3] The tide at Point Hope is probably considerably less than two feet, but it is sufficient to give at the ebb a current to the southwest off the northwest shore of Point Hope.[4] This tidal-ebb current from the northeast would neutralize the tendency of the coast current to turn the point of the spit northward and the collision of the two currents would lead to the shore waste which they carried being dropped so as to build the point in a westerly direction. The cliffs forming the coast line at Cape Thompson have a northwest-southeast trend for six miles or more, giving the coast current its initial northwesterly or seaward trend. North of the Kukpuk River for nearly thirty-five miles the coast line of cliffs trends nearly north and south. This contrast in the trend of the coast on the north and the south sides of the point

[1] U. S. Hydrographic Office, Chart of the Bering Sea and the Arctic Ocean.

[2] Harris, *Eighth Intern. Cong. of Geog.* p. 399, 1905.

[3] DeLong, *Voyage of the "Jeannette,"* p. 890, 1883.

[4] Capt. F. W. Beechey, *op. cit.*, p. 577.

probably gives rise to a slight backset or eddy current to the southwest on the north shore of Point Hope, which may be an element in giving the spit its cuspate form.

In addition to the familiar marine agents, waves, tides, and currents, which are involved in shaping the shore-line features of all coasts, we have on the Arctic coasts a fourth agency which at times acts with far greater power and rapidity than either of the above-named influences. This is the Arctic ice-pack. The shallow character of all the navigable portion of the Arctic Ocean, north of Bering Strait which seldom exceeds 30 fathoms, affords peculiarly favorable conditions for the excavating and plowing activities of the ice-pack when grounded and under pressure. The nature of the difference between ordinary sea ice and the ice of the ice-pack is indicated in the following extract from Captain Hooper's "Ice Notes":

> The greatest thickness attained by direct freezing is about eighteen feet, at which thickness the increase by freezing at the bottom does not exceed the waste at the top by evaporation, which goes on slowly but surely at all times. The maximum thickness by direct freezing is generally reached the third winter. It is seldom that more than nine feet forms during one winter. The extraordinary thickness attained by the pack is due to accumulations of these naturally formed layers as they are forced one over the other by pressure due to currents of air and water. On account of the difficulties of ascertaining the thickness of the ice by measurement, the most reliable way appears to be by noting the depth of water at which it touches the bottom. This we found at Herald Island, Wrangle Island, and on the coast of Asia near Cape North to be about ten fathoms. In Bering Sea we made fast to ice grounded in six fathoms, and passed a number of detached pieces ground in eight fathoms.[1]

Osborn thus describes the ice encountered by McClure off the north coast of Alaska:

> Ice of stupendous thickness and in extensive floes, some seven or eight miles in extent, was seen on either hand; the surface of it is not flat, such as we see in Baffins Strait and the adjacent seas, but rugged with the accumulated snow, frost, and thaws of centuries.[2]

Captain McClintock, in passing around the north coast of Alaska, generally found the heavy ice aground in six or eight fathoms of water, leaving a comparatively ice-free tract of water, three to six fathoms deep, between the ice-pack and the coast, through which he laid his course.[1]

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[1] Capt. C. L. Hooper, "Rept. of the Cruise of the U. S. Revenue Steamer 'Thos. Corwin' in the Arctic Ocean, 1881," *48th Cong. Ex. Doc., No. 204*, p. 128, 1884.

[2] McClure, *The Discovery of the Northwest Passage*, edited by Osborn, p. 83, 1857.

All observers agree in ascribing great thickness to the ice of the Arctic ice-pack. The whalers distinguish it from the ordinary sea ice produced by one or two winters' freezing by calling it the "big ice."

Jarvis, in speaking of the ice-pack of the Alaskan coast, states that

> though the pack contains no real icebergs it nevertheless extends six to eight fathoms below the water and occupies from a third to a half the depth of the shallow Arctic Sea.

Lieutenant Chas. H. Stockton, of the U. S. Navy, thus describes the action of this ice when it is driven ashore:

> Sometimes a long line of heavy floe ice from the pack grounds in the shallow water near the shore during northerly winds, pressed from behind by the force and the weight of the entire northern pack. It is gradually forced up, plowing its way through the bottom, at the same time rising gradually along the ascent of the bottom toward the land.[2]

Lieutenant Stockton made a hydrographic survey of the anchorage near Point Barrow in which he

> demonstrated that the contour of the bottom is constantly changed by the plowing and planing done by the heavy ice grounded and driven up by the pressure of the mighty ice-pack, under the influence of northerly winds and gales.[3]

In this connection the observations and opinion of Mr. A. J. Collier who has seen much of the Arctic coast of Alaska is of interest. He states that

> Dr. E. O. Campbell, government school-teacher at Cape Chibukak, St. Lawrence Island, whose residence is nearly one-half mile back of the beach, reports that he has often feared the destruction of the mission buildings from the same cause (driving ashore of the ice-pack). The beach at Cape Chibukuk is marked by a series of regular ridges parallel to the shore, said by Dr. Campbell to have been pushed up by the ice-pack. In view of these considerations the barrier beaches of the shores of the Arctic Ocean and Bering Sea, though in nearly all respects they resemble the barrier beaches formed by wave and current action in southern altitudes, must in the opinion of the writer be regarded as in part due to material pushed up from the sea-floor by the ice-pack and only transported in a minor

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[1] Osborn, *The Discovery of the Northwest Passage*, p. 71, 1857.

[2] Chas. H. Stockton, *Natl. Geog. Mag.*, Vol. II, 1891, pp. 182, 183.

[3] *Ibid.*, p. 182.

degree by wave action. Barrier beaches of this type are of common occurrence along the shores of the Arctic Ocean in Alaska from Cape Prince of Wales to McKenzie River.[1]

The preceding quotations seem to make plain the fact that the pack ice along the Arctic coast should be considered along with currents and waves as one of the most effective agencies concerned in the formation of shore-line features. When it is remembered that the navigable portion of the Arctic Sea northwest of Alaska shoals regularly from a maximum depth of about thirty fathoms toward nearly every part of the Alaskan coast, it will be seen that the conditions are peculiarly favorable for the grounded ice-pack to carry great quantities of submarine deposits to and toward the beaches. The reworking of these transported materials by wave action seldom leaves any permanent features which can be ascribed solely to ice action.

The Arctic ice-pack never retreats far to the north of Point Hope even in midsummer. The observations of Captain A. J. Henderson of the revenue cutter "Thetis" would indicate that it was probably not more than 100 miles to the north of Point Hope at any time during the past summer.

According to Dr. Driggs, the missionary at Point Hope, the ice-pack comes down from the north and closes on the spit before any very considerable amount of local ice has formed on the sea. This usually occurs late in October or in November. In 1908 the bulk of the ice-pack left the Point July 28. It usually leaves early in July. The period during which the Point is subject to wave and current action is therefore limited to about one-fourth of the year. It is probable, however, that the ice-pack is more effective during the other three-fourths of the year in moving submarine materials toward the spit than waves and currents would be.

Mr. Allen, a whaleman who has lived for several years on the Point Hope spit, told the writer that at times in the winter the ice-pack is forced against the south shore of the spit with a force that makes the entire spit tremble as from an earthquake. Joseph Tuckfield, another whaleman who formerly lived on the spit opposite the mouth of the Kukpuk River, was compelled to remove his house to an island in the inlet on account of the danger of the ice-pack over-riding the spit in winter.

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[1] A. J. Collier, "Geology and Coal Resources of the Cape Lisburne Region, Alaska," *U. S. G. S. Bull. No. 278*, p. 34, 1906.

It will readily be seen that a solid ice-pack six or eight fathoms in thickness, which would be of sufficient thickness to ground a little distance off the shore of the Point Hope spit, would be a most effective agent in ridging or piling up in front of it and shoving shorewards the unconsolidated gravels and sand at the bottom, under the influence of pressure from the south. Such a grounded ice-pack driven by the combined pressure of heavy south winds and the north-setting current as the pack starts north in summer undoubtedly plays an important rôle in the growth of the spit by shoving the sands and gravels of the bottom up within the limits of effective wave action. The pack no doubt acts similarly at times in bringing materials up on the northwest shore, but it has already been pointed out that at present destructive agencies are more effective on that side of the spit than are the combined constructive agencies.